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ABSTRACT

The value of microcomputer modeling tools and spreadsheets to help college institutional researchers analyze proposed capital projects is discussed, along with strengths and weaknesses of different software packages. Capital budgeting is the analysis that supports decisions about the allocation and commitment of funds to long-term capital investment projects. For capital projects, modeling techniques can be used to test the implications of various key factors affecting different options, and to help determine the best policy and operational alternatives. Steps in the analysis include: gathering such information as space requirements, staffing levels, and operating budget of the relevant programs or functions; summarizing these data and making calculations (e.g., gross square feet, recoverable and unrecoverable costs); reviewing cash flow implications based on principal and interest payments over the life of the project, incorporating applicable overhead recovery formulas, and calculating the net present value of the cash flow. For academic and research facilities, the model assesses the short-term and long-term impact of the project on the institute's overhead rate. In addition to identifying the benefits of spreadsheets, the following types of spreadsheet packages are reviewed: Multiplan and Lotus 1-2-3. (SW)

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USING SPREADSHEET MODELING TECHNIQUES FOR CAPITAL PROJECT REVIEW

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Elizabeth F. Fox, Chair
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Abstract

Anticipating the effects of a proposed capital project on a university is an inexact science at best. Shifts in space utilization and staffing are important considerations along with project funding and long-term effects on cash flow. The growing accessibility of microcomputers and the capabilities of currently available spreadsheet packages offer an opportunity to assemble a variety of capital project information in a concise, useable format with relative ease. This paper examines the capital project planning cycle, the application of spreadsheet modeling techniques, and explores the strengths and weakness of different software packages.

Capital Projects and University Planning

A continuing problem faced by university administrations is how to make the best allocation choices among a set of needs which are far larger than the institution's currently available resources. This is especially true in the area of capital facilities which not only must be maintained in good operating condition, but which also must meet the changing needs of the university's academic and research programs, student body size and demography, and pressures from the external environment. Capital budgeting is the analysis which supports decisions about the allocation and commitment of funds to long-term capital investment projects, and it involves not only estimation of a project's component costs, but also analysis of the cash inflows and outflows which will have an impact on the institution's continued financial viability. Slavin, Reynolds, and Miller (1972, p. 793).

Spiro (1977, p. 108) minces no words in describing the importance of this activity. He states:

> [Capital budgeting] deals with the very core issue of management: allocation of available resources to secure future returns. This is not only the domain of financial management; every manager is in fact continually faced with capital budgeting decisions.

Although he is discussing capital expenditures for equipment as well as plant, Spiro is on the mark in discussing the the basic cost-and-benefit-over-time nature of these decisions. He also defines capital budgeting as largely a technical process, one in

which relies on financial concepts such as net present value (NPV) and internal rate of return (IRR), and which excludes all factors not directly related to the project itself, including sources of funds and some type of overhead.

Adherence to these stricter accounting principles may be a requirement for the university's formal capital budget as part of its management accounting system, and normally prepared by the Budget Office or similar department, but a full review of proposed capital projects should also include non-financial considerations such as siting and special program characteristics. Capital project analysis, as described in this paper, refers primarily to major renovations or additions to physical plant and is not necessarily part of the institution's capital budgeting process. Obviously any form of capital analysis should have some relationship to the ongoing budget, but the focus here will be more on programming rather than budgeting issues.

Not all educational institutions need a formal programming system for considering individual programming proposals. Those with essentially stable programs can use the techniques outlined here on an ad hoc basis, but those which may have several projects under consideration or in progress may do well to implement a process for a standardized review and approval process if one is not already in place. Anthony and Herzlinger (1980, p. 298) suggest that such a system is worthwhile if an organization meets any one of five criteria:

- There is a need to make a number of program decisons

each year;

- Interrelationships among the several parts of the organization are complicated;
- Implementation of program decisions requires a fairly long lead time;
- Complex scheduling of program elements is required to bring activities and capital investments into being in a particular sequence;
- Resources are particularly scarce and the number of desirable programs is quite large.

As a major research university, the Massachusetts Institute of Technology meets all of these criteria, often having several projects under construction or in the planning stages simultaneously. The description of a capital projects planning system being developed at MIT, in an unpublished paper by Simha (1982, p. 1), identifies seven phases in the planning cycle:

I. Initiation

II. Preliminary Analysis

III. Planning

IV. Program

V. Design

VI. Construction

VII. Occupancy

Critical to informed decision-making in the early stages of a project's life, before substantial design and construction costs have been incurred, is Phase II, the preliminary feasibility

analysis. It is in this area that data are collected and assembled according to a standardized format, and a variety of alternatives are examined. The resulting document is then submitted to senior administration for review and approval.

Strategy and Planning

In a discussion about planning for an institution's information technology needs, Emery (1984, p. 5) illuminates several issues which are also relevant to capital planning. First, there is a necessary relationship between short-term planning and conditions in the distant future. Failure to anticipate longer-term needs can cause serious problems. Second, a plan should not go into more detail than necessary, since these details can change significantly and it is important not to get mired in tactical or operational discussions before the project has been approved. Third, preserving options is a critical element of any good plan. Development of a framework in which prototype applications can be reviewed helps preserve options and facilitate learning. Fourth, a plan must be flexible enough to withstand change. The ability to accommodate revision is essential in order to best represent current estimates of the future.

The use of modeling techniques can incorporate the necessary flexibility and maintenance of options cited by Emery. Massey and Hopkins (1979, p. 33) suggest that using models adds another critical element, that of organizing thinking and opening methodology and assumptions to debate. "Consultation with

faculty, trustees, and students should be viewed as a process of developing and refining judgements, and reaching a collective understanding about the reasons for them."

Shirley and Lorang (1979, p. 193) draw six conclusions from an experience of using modeling techniques for operating budget review at the State University of New York at Albany:

- The forecasting model provides a useful tool for identifying both the nature and magnitude of potential financial problems.
- It is of little use to identify potential problems if no mechanisms are developed to address those problems in a systematic way.
- It is critical to involve all major actors in the project from the outset.
- The basic model is of real value at the presidential and vice presidential level because of the aggregation of data.
- The value of a long-range (more than one-year) forecast is greatly conditioned by the time perspectives employed by those state officials who determine the campus budget.
- The model also provides a useful tool for evaluating the effects of alternative financial policies.

For capital projects, the model can be used to test the implications of various key factors affecting various options, and to assist in the determination of the best policy and operational

alternatives. The approach to capital budget modeling begins with gathering the basic information which define the scale and character of the project (e.g. space requirements, staffing levels, and operating budget of the relevant programs or functions). From these base data, the model can project such things as space requirements for different staffing levels, staffing levels for different operating budgets, required parking spaces based on building size or number of personnel, and so on.

The next step is to summarize these data for the project as a whole. From that summary the model calculates gross square feet and can include alternatives based on projected program growth (e.g. 5% growth, etc.). Using a pro forma construction budget prepared by the physical plant department or other appropriate administrative unit, the model then calculates construction and final project costs, identifying recoverable and unrecoverable costs, as appropriate. An inflation factor is included to identify the effects of project scheduling changes. The project funding component then allows for a description of funding sources (gifts, bonds, etc.) and calculation of net capital need (including the recoverable and unrecoverable portions). From these data, the annual principal and interest costs are derived.

The next section of the analysis reviews cash flow implications based on principal and interest payments over the life of the project, incorporating applicable overhead recovery formulae, and calculates the net present value of that cash flow. This allows senior administration to assess the project's impact

on the Institute over the long term, and understand more fully its potential effect on other institutional initiatives.

Finally, for academic and research-related facilites, the model assesses the short-term and long-term impact of the project on the Institute's overhead rate. This is very useful in build-versus-rent comparisons and in scheduling projects over time to minimize large fluctuations or severely negative effects on the cost of doing business.

Spreadsheets as Modeling Tools

Given the usefulness of models in the planning process and for providing management information, the question becomes one of choosing an effective modeling tool for capital budget analysis. The growing accessibility of microcomputers and the ubiquity of spreadsheets as a way of organizing numerical data make this type of software a natural application for exploration. Indeed, as Levy (1984) points out, spreadsheets have become a metaphor, way of thinking. They allow us not only to organize data, but to ask the "what-if" questions essential to building effective models. Hutten (1984, p. 49) goes so far as to call the spreadsheet "...an ideal tool for modeling activities of any sort in research and planning offices."

This power and convenience has had a significant effect on the tools used for institutional research and planning. Suttle (1984, p. 32) identifies the trend toward adaptation of large, complex models originally developed for mainframe computers to run on microcomputer spreadsheet software. He cites the transition at

both Harvard and Yale from budget planning on EDUCOM's EFPM system to Lotus 1-2-3, and conversion of tuition and financial aid data from mainframe SPSS to micro-based SuperCalc.

Because of the amount and variety of data necessary for adequate capital project analysis, this is both good news and bad news. The good news is that using spreadsheets for capital project review offers an opportunity to assemble a variety of information in a concise, useable format with relative ease. They are also "...faster and more 'interactive' [than systems which require the user] to write a program, store it, and then call up the result." Howitt (1985, p. 30). The bad news is that building complex spreadsheet models can demand a more thorough knowledge of the software than we may presently possess. Further, spreadsheets also make it possible "...to make more mistakes, and to multiply them rapidly." Howitt (1985, p. 26)

In Howitt (1985, p. 27) author and consultant Jack Grushcow offers ten suggestions for spreadsheet design which can help minimize errors and avoid disaster in building complex models which may be shared by others:

1. Don't start without a plan.
2. Use your cell protect feature.
3. Don't mingle data entry areas with calculations
4. Make your data input resemble existing forms.
5. Use the data input area as a data capture form.
6. Enter data in either rows or columns, not both.
7. Use manual recalculation when entering data into

large spreadsheets.

8. Place instructions and identification in the spreadsheet.

9. Back up your files.

10. Always test your spreadsheet.

Spreadsheets, by their nature, hide the logic, the details of the calculations, from the user. And to complicate matters further, spreadsheets are useful not just to illuminate, but to convince. "Because a spreadsheet looks so authoritative - and it was done by a computer, wasn't it? - the hypothetical models get accepted as gospel....This use of spreadsheets has less to do with productivity or insightful analysis than with the art of persuasion." Levy (1984, p. 64).

This means that planners and institutional researchers must take on a special responsibility to ensure that information is accurate and complete. Capital resources may be legally the property of the institution, but they may be owned, envied, or feared by many individuals, and a key role in the process is that of the person who can interpret not only the data, but also the limitations of the model (and of the criticims levelled against it). Mayo and Kallio (1983) note that the potential for misusing a model always exists, and that ongoing discussions about its strengths and weaknesses in an important element of the model development process.

Applications: Choosing an Alternative

The choice of appropriate spreadsheet software is sometimes

limited by existing hardware. For example, the user of an 8-bit CP/M machine cannot choose to use a package like Lotus 1-2-3. More often, though choices may be dictated by such considerations as cost, ease of use, and compatibility with other users' systems. Emery (1984, p. 5) notes that "[t]he software problem certainly does not stem from a lack of products....Choosing an adequate - let alone the best - product in the din of the marketplace is exccedingly difficult and time consuming."

This review focusses on two common, but quite different spreadsheet packages, Microsoft's Multiplan and Lotus 1-2-3. A non-spreadsheet modeling tool, TK!Solver from Software Arts (now part of Lotus Development Corp.) has also been included in an effort to maintain a broader perspective on both the modeling tools and the thinking processes.

These choices may also reflect common stages of technical development for individuals and departments. For many, the first microcomputer system was an 8-bit CP/M system for which VisiCalc or Multiplan may have been the available spreadsheet tool. Later, the user may have acquired a 16-bit machine running MS-DOS or CP/M-86, leading to the world of Lotus 1-2-3 and TK!Solver. Rubin (1984, p. 218) uses two examples of this progression from simpler to more complex spreadsheet software to bolster his contention that learning to use these tools "...is much more a journey than a quick fix."

Multiplan (Microsoft Corporation, Bellevue, WA). Multiplan is easy to learn, yet offers some very powerful features. As a

menu-driven spreadsheet, its operation is relatively simple, and commands like NAME and EXTERNAL COPY, as well as its built-in functions like SUM and NPV allow simplified equations and the linking of worksheets, making updating and program documentation easier. Disadvantages include limited usable worksheet area (a function of CP/M-80 which does not apply to the CP/M-86 version), and the lack of programming capability. This means that to load, update, save, and print several worksheets, the user must initiate all commands manually. With a complex model, this can become an extremely tedious task.

Lotus 1-2-3 (Lotus Development Corporation, Cambridge, MA). 1-2-3 is a more powerful spreadsheet which includes the ability to string several commands together in a "macro" command, thus cutting down repetitive keystrokes and making the model programmable. It does not allow for the linking of worksheets in the same way Multiplan does, but the programming capability, database functions, and size of the worksheet offer powerful alternatives for reaching the same ends. Lotus 1-2-3 can also easily generate graphics output. The main disadvantage of 1-2-3 is its complexity, the price of its power and flexibility. Learning to use it can take much longer, especially for effective use of its programming capability. In addition, a substantial amount of random-access memory (RAM) is required (256K minimum as opposed to 64K for Multiplan) and the graphics capability is somewhat limited (e.g. pie charts cannot be filled in or shown with exploded sections).

TK!Solver (Software Arts, Inc., Wellesley, MA). TK!Solver is an "equation solver," a very different modeling tool from spreadsheets like Multiplan or Lotus 1-2-3. The model consists of a set of equations (or rules) which describe the relationships between defined variables. The spreadsheet packages also use rules and defined variables, but they are arranged in discrete cells requiring unique addresses (e.g. row 1, column 1). Because TK!Solver defines these relationships without needing to rely on cell addresses, it is far more efficient and its models run much more quickly. In addition, there is no need to link worksheets or write macro commands. Disadvantages of TK!Solver include the time it takes to learn the program (its models are more abstract and may seem more difficult to define at first) and its extremely limited report generation capability.

Conclusions

Spreadsheets and other microcomputer modeling tools can make it possible for institutional research offices with limited budgets or staff with limited computer science backgrounds to provide sophisticated analyses of proposed capital projects quickly and easily. By reviewing such models at an early stage in the project's development, unanticipated financial impacts can be minimized.

The critical elements in model development include selection of appropriate software, careful documentation of the model's logic and assumptions, review of both the models and the results by key people, and flexibility of the system to accommodate

changing information. The model should clearly display both short-term and long-term effects under a variety of potential circumstances.

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